AGE DIFFERENCES IN RETENTION AFTER VARYING STUDY AND TEST TRIALS

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AGE DIFFERENCES IN RETENTION

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INTRODUCTION

A well documented finding in gerontological research is the decreasing ability of older subjects to remember recently acquired verbal material (Welford, 1958; Birren, 1970; Monge, 1969; Goulet, 1972; Botwinick, 1973). The finding has been confirmed by a myriad of tasks including free recall (Laurence, 1966a, 1967; Schonfield, 1965, 1967); paired-associate learning (Wittels, 1972; Monge and Hultsch, 1971); verbal discrimination (Nehrke, 1973); letter-span tasks (Kinsbourne, 1973; Talland, 1968); free association (Moenster, 1972); and running digit-span tasks (Talland, 1968). Stimulus materials that have elicited a decrement in memory with aging include lists of words (Schonfield, 1965, 1967); nonsense syllables (Drachman and Leavitt, 1972); meaningful material (Gordon and Clark, 1974); letters of the alphabet (Kinsbourne, 1973; Talland, 1968); orders of approximation to English (Craik and Masani, 1969); numbers (Talland, 1968); and pictorial material (Laurence, 1966b).

Memory Systems Involved In The Memory Deficit With Aging

Welford (1958) originally postulated that the decrement in memory with aging was due to the impairment of short-term memory in the aged. In recent years, however, the term "short-term memory" has undergone a specializing process among memory theorists. To them

short-term memory (STM) means essentially the immediate memory span. Its contents are measured by the number of items an individual can retain simultaneously. When viewed as the immediate memory span, STM has little involvement in the deficient memory of the aged (Craik, 1968; Talland, 1968). For example, Talland found that the forward digit span (a task in which the subject is required to repeat a list of numbers in the same order that they were presented orally by the experimenter) was not affected by age when no other tasks were superimposed.

The distinction between short-term memory and other memory systems is not without controversy. That is, certain memory theorists still argue about whether or not STM is legitimately distinguishable from other memory systems except in an operational manner (e.g., as recall prior to the elapse of x seconds after presentation of the material). There are several positions on this issue. One-process theorists (e.g., Melton, 1963; Murdock, 1967; Craik and Lockhart, 1972) take the view that retrieval of material from memory occurs in the same manner regardless of the amount of time that has elapsed since aquisition. Some two-process theorists (e.g., Waugh and Norman, 1965; Atkinson and Shiffrin, 1968) argue that there is a complete separation of short-term memory and long-term memory (LTM) with limited capacity and serial storage in short-term memory and "unlimited" capacity and storage by content meaning in long-term memory. Other two-process theorists, Tulving (1968), for example, contend that items in STM and LTM are "stored" in the same place but accessed or retrieved differently.

A third position, taken by some perceptual theorists such as Broadbent (1965), postulates various perceptual memories which hold information before it is processed into STM or LTM.

Whatever the real state of the divisibility of memory processes into separate memory stores or systems, one can safely say that healthy, older subjects do not differ consequentially from younger ones in their ability to recall items such as letters or numbers if (1) there are few items, (2) recall immediately follows presentation, and (3) presentation time is long enough, i.e., over one second (Craik, 1968; Talland, 1968).

The Memory Deficit as a Consequence of Other Deficits Associated with Aging

Several broad general hypotheses have been advanced to account for the long-term memory impairment seen in older people. These theoretical notions center around the idea that the memory deficit is a side effect of other processes covarying with age. Birren (1970), for example, has suggested that a general slowing down of the central nervous system could account for the older person's poorer performance on memory tasks. Much of Birren's evidence stems from reaction time experiments.

Learning Set Deficit

Both Monge (1969) and Goulet (1972) have postulated that older adults may have a more difficult time in remembering new material because of a lack of non-specific transfer or learning-to-learn. Goulet (1972), for example, has suggested that there exist "enactive" skills, which involve learning how to do something and "inhibitory" skills,

which involve suppressing learned material. He proposed that during childhood an individual learns more enactive skills, and that the enactive skills and inhibitory skills are learned equally often during middle adulthood, but that as one approaches old age, inhibitory skills are more frequently learned. Hence, an older adult is more likely to "inhibit," or presumedly to forget, what he has learned in any situation.

Rigidity

Botwinick (1968) has suggested that the inability to learn new items may be due to rigidity. Rigidity was defined as the inability to change strategies when the original strategy is no longer applicable.

Motivational, Cohort and Other Age Differences

Other variables that Botwinick thought might contribute to the differences found in memory performance between older and younger groups include differential cooperation of subjects in different age groups, differential reactions to novel situations, and cohort differences (that is, differences due to generational experiences rather than to a particular aging process phenomenon). Schaie (1968) has argued that cohort differences explain much of the variability of performance with aging.

Necessity of Controlling Variables Extraneous to the Memory Deficit with Aging

While these factors are undoubtedly important in the memory deficit with aging, there is increasing evidence that the decreased memory ability as a function of age extends beyond them, and hence that they should be viewed as additional rather than as primary factors. These factors (motivation, learning set, cohort differences, etc.) should be controlled, used as mediators, or otherwise accounted for before one ascribes any

differences between two age groups as due to a memory process per se. For example, based on Birren's (1970) thesis that the memory loss with age can be explained by the general slowing down of the central nervous system, one should attempt to provide ample time for acquisition of the material and for testing of subjects so that one does not confuse an acquisition problem with a memory problem.

The question of cohort differences is particularly germane to a study that involves subjects ranging in age from eighteen to eighty years old. In view of changing educational practices and technological advances, many of these subjects will have experienced different ways of learning material.

One way of controlling for cohort differences is through the use of longitudinal studies in which the same subjects are tested over the period in which one is interested. Although a longitudinal approach offers a way of looking at individual curves rather than group or "averaged" curves, data collection takes a very long period of time--in the case of aging, some sixty years or more. Another problem with longitudinal studies is the effect of test sophistication or improvement with practice shown by individuals tested often. Longitudinal studies suffer also the possibility of selective attrition of subjects with lower abilities (Schaie, Labouvie, and Barrett, 1973). For these reasons, cross-sectional studies in which different age groups are compared at the same time are often used in examining memory impairment with aging. Arenberg (1977) has reported results of investigations showing similar age functions on memory tasks when cross-sectional and longitudinal are used.

Theories of Forgetting

Two memory theories that are frequently invoked to explain why older people do not remember as well as younger ones are interference theory and decay theory. As Botwinick (1973) and others have argued, to say that decay causes forgetting is to say nothing more than that forgetting causes forgetting. The idea of a decaying memory trace adds little except perhaps vividness to the frame of reference. Similarly, Smith (1970) contended that to have heuristic value, interference theory must denote the subject and object of interference as a cause of forgetting.

Current Research

Although theories tend to center around broad general hypotheses, current research concerns itself with answering specific questions about memory functioning across the age range. A more molecular approach, such as the one taken in the recent development of the experimental psychology of memory, may prove expedient in generating specific testable hypotheses about the memory deficit with aging.

Storage-Retrieval Controversy

One such hypothesis concentrates on the storage-retrieval difference--that is, whether the memory decline with aging can be attributed to learning (storing) the items or whehter it concerns retrieving the items from storage once they are learned. The distinction between storage and retrieval has received considerable attention in memory research (e.g., Tulving and Pearlstone, 1966).

Methods of Separating Storage and Retrieval. There are several

ways to separate storage and retrieval experimentally: (1) items per category recalled (as a measure of storage) vs. number of categories recalled (as a measure of retrieval); (2) cued recall (storage) vs. uncued recall (retrieval); (3) free recall (retrieval) vs. recognition (storage); and (4) differential practice in study (storage) trials as opposed to differential practice in recall (retrieval) trials. In addition, subjects often seem able to list characteristics of words apparently in storage even when they can not retrieve the words. For example, they might report the initial letter of the word, the number of syllables the word contained, etc., even though they could not produce the whole word (Brown and McNeill, 1966).

Research In The Storage-Retrieval Controversy And The Memory Deficit With Aging. Using recognition vs. recall as a method of separating storage and retrieval, Schonfield (1965) and Craik (1972) found that young and older subjects did not differ on recognition tests (generally considered a measure of memory that minimizes retrieval) but that younger people performed significantly better than older people on recall tests (usually held to involve a larger retrieval component).

McNulty and Caird (1966, 1967) suggested that Schonfield's results were due to the fact that recognition of the words required only partial storage and hence that the interaction between age and type of task should not have been attributed solely to a retrieval deficit. Partial storage refers to the storage of some aspect of the item, such as a letter or part of the meaning, instead of the storage of the whole and exact word. McNulty and Caird (1966, 1967) thought that perhaps some

part of the word was stored by the individual, and that when presented with the recognition test, the subject had only to look for a word that approximated the part he had stored, while if given a recall test, the subject had to reproduce the whole word. Thus an older person's recognition score would be increased even if he had only partially stored the item.

A recent experiment by Smith (1975) failed to support McNulty's and Caird's speculation about the equal performance of younger and older subjects on recognition tests. Smith varied the nature of the incorrect alternatives at the time recognition memory was tested. Some of the alternatives were phonetic variations of the word tested, and some were semantic variations. That is, the recognition test contained words such as boy which could have as alternatives phonetic variations (e.g., toy) or semantic variations (e.g., lad). Both younger and older subjects performed equally well on this task which minimized the use of partial information by the subjects.

Categories Recalled. Further support for the retrieval deficit hypothesis comes from experiments by Craik and Masani (1969) and Laurence (1966).

Craik and Masani (1969) presented a categorized list of words for free recall and used items-per-category as a measure of storage and number of categories as a measure of retrieval, thus incorporating the methodology developed by Tulving and Pearlstone (1966). This methodology consists of presenting the subjects with a list of words belonging to different categories such as "animals" or "countries." The number of words-per-category is the average number of words recalled from each

category that was included in the list. Examples of words under the category "animals" include dog and cat, while examples of words under "countries" include Brazil and England. The number of categories represented in the recall protocols is measured by the number of categories from which at least one item is remembered. The assumption is that if the subject remembers the name of a category, he will have a retrieval plan. Hence, the number of categories recalled assesses retrieval, and the number of words recalled per category gives a measure of the number of items stored.

Craik and Masani (1969) found no difference in the items-per-category recalled by the two age groups; however, the younger subjects remembered significantly more categories than the older ones. The better performance of the younger subjects in the number of categories recalled lends support to a retrieval difference, while the equal performance between the two age groups in remembering items-per-category weakens the argument of storage differences.

Subjective Organization. Laurence (1966) found that measures of "subjective organization" (the tendency of repeatedly recalled items to follow each other in a consistent pattern across trials) were equivalent in different age groups, thus suggesting that the memory deficit in old age is not one of storage, at least not that part of storage due to different organizational abilities.

Cued vs. Noncued Recall. Evidence seemingly inconsistent with the retrieval hypothesis comes from Drachman and Leavitt (1972), who found that older subjects were not differentially aided by cued recall.

The performance of older subjects was worse than that of younger ones by approximately the same amount on both cued and noncued recall. Since cued recall is thought to aid retrieval (e.g., Tulving and Pearlstone, 1966), the results of the Drachman and Leavitt (1972) study support the view of storage as the problem of memory impairment with age. One questionable feature of the Drachman and Leavitt study, however, was their use of only structural cues (initial letters of the alphabet). It seems more probable that items may be retrieved from memory on the basis of semantic as well as or more so than phonemic features of the items, especially if the items are words rather than nonsense syllables (which were in Drachman's and Leavitt's study). A recent study by Smith (1977) supports this interpretation.

Differential Practice In Storage (Study Trials) And Retrieval (Test Trials). Another method of determining whether the memory deficit with aging is due to storage or retrieval is the addition of extra study or extra test trials in standard multi-trial free recall tasks to see if either of these additions differentially affects the performance of older subjects.

The idea that practice in retrieval may aid performance as much as practice in studying the items has been prevalent since Gates' (1917) classic experiment. Gates showed that practice at reproducing to-be-remembered material facilitated later recall. A more recent method has been formulated by Tulving (1966, 1967) and his cohorts and developed by Hogan and Kintsch (1971) and Hartley (1974). On each trial a subject can be presented with the list of words (a study trial) or the subject

can be given a test on the items of the list (a test trial).

In Tulving's (1966, 1967) original research, there were three groups of subjects. Subjects in one group were presented with what is considered a standard order of trials. The standard order consisted of a presentation of the items (study trial) followed by a test on the items of the list followed by an additional presentation of the list (study trial) and an additional test trial. This group was later called the study-test-study-test (STST) group.

Another group of subjects was presented with the items three times before being tested on them. This group became known as the study-study-study-test (SSST) group. A final test group was presented with the items once and subsequently tested on them three times before being presented with the list again. Tulving's test group was referred to as the study-test-test-test (STTT) group.

The results of Tulving's experiments revealed no significant differences between the three college-aged groups in overall performance. The STTT group, however, recalled significantly fewer items than the other two groups on its last recall trial preceeding another cycle. In this procedure a cycle consists of four trials. Hence each successive recall trial after presentation of the items for the STTT group contained fewer words than the previous trial. In contrast, the first recall attempt in the next cycle contained significantly more words than the third and last recall trial in the previous cycle and as many words as in the other two groups' (STST's and SSST's) performance.

Tulving discussed his results in terms of availability and accesi-

bility of items. The study trials were viewed as aiding the subjects in terms of storing the items or making them available, while the test part of the cycle was thought important in aiding the retrieval or making the items accessible.

Further comparison of two of the groups--the STTT group, which received one study trial (presentation of the items) followed by three test trials, and the SSST group, which received three study trials in a cycle before being tested in that cycle--was undertaken by Hogan and Kintsch (1972). In their experiment Hogan and Kintsch compared recognition and recall as methods of testing for retention. Each group--SSST or STTT--was presented with either a recall or recognition task for each test during the one cycle that was presented. Forty-eight hours later the same type of test was given to each group followed by an additional test with the opposite method (recognition or recall) from that received during the cycle.

The results supported Tulving's findings and generalized the results to include situations when only one cycle was given and when the experimental test was given after a delay of forty-eight hours. The STTT and SSST methods were equivalent in effectiveness for free recall performance. That is, test trials aided subjects just as much as study trials did when there was only one cycle, when recall was delayed forty-eight hours, and free recall was the measure of performance. This result was true whether recognition tests or recall tests were presented during the cycle.

Results of the Hogan and Kintsch study support both (a) recogni-

tion tests as measures of storage and study trials as aids in storage and (b) recall tests as measures of retrieval and test trials as aids in retrieval. In other words, the interaction between method of study and method of testing points out the effectiveness of each in separating storage and retrieval since they interacted in the expected direction. Hence performance by groups that employed the three study trial (SSST) method could be called a storage score and performance by groups that employed the three test trials following a single study trial (STTT) could be called a retrieval score. Hogan and Kintsch used college-aged subjects in their study.

Hartley (1974) was unable to replicate Tulving's findings for the STTT and STST groups. Using randomized and blocked presentations of a categorizable list of words, she hypothesized that blocked presentations of a categorizable list would enhance accessibility (retrieval) of words for the STST group and hence improve performance in this condition. She found that both blocked and randomized lists of categorizable words were remembered better by the STST group than by the STTT group. A second study was designed to determine if words-per-category could account for the inconsistencies between her findings and those of Tulving and Pearlstone (1966) and Tulving (1967).

In Hartley's first study ninety-six words from sixteen categories (six words per category) were presented. In a second experiment ninety words were presented with either three, six or nine words per category, and hence either thirty, fifteen or ten categories. For each group the order of the words was randomized. Whereas in the first experi-

ment words-per-category, number of categories, and total number of words recalled were all significantly better in the STST (Standard) group, in the second experiment the Standard group was superior only in number of categories and therefore in total number of words recalled. The two groups did not differ significantly in words-per-category recalled.

Hartley's experiments suggest the possibility that test trials aid the subject in remembering items of a category once the category appears, while the standard procedure emphasizes the learning of particular items. As Hartley pointed out, her results were limited by the inclusion of only three cycles in the first, and two cycles in the second experiment; thus, her findings may not be generalizable to experiments in which a greater number of cycles are completed.

As discussed earlier, words-per-category recalled is considered a measure of storage and number of categories recalled is considered a measure of retrieval. Hartley's experiments seem to point at a possible interaction of rote and cognitive memory. It would seem that fewer test trials, which apparently aid in retrieval from rote memory, are needed when the stimulus materials offer an opportunity for higher order organization.

CHAPTER II

RESEARCH PLAN

The research reported in this thesis attempted to study closely the problem of storage and retrieval in the memory impairment seen with normal aging. The methodology was similar to that instituted by Tulving (1967) and developed by Hogan and Kintsch (1972).

In this experiment four conditions were presented to two groups--young and old, apparently healthy, verbally facile males. Two of the conditions were similar to the STTT groups described previously in which a single presentation of the items (study trial) was followed by three test trials in a cycle. Two of the groups (SSST groups) received three study trials before bing presented with a single test trial. There were four initial cycles which were identical to each other within groups but different across groups. The final cycle was identical for all groups in terms of method of presentation: a study trial, a test trial, another study trial and a final test trial. Method of testing was also varied. Half of the subjects in each condition had to write down as many of the items as they could remember at the time of testing (Recall). The other half had to choose between alternative words (Recognition). The design of the experiment is presented in Table 1.

Hypotheses

The methodology offers two different ways of testing the storage and retrieval hypotheses. The first hypothesis is that of an interac-

Table 1. Experimental Design.

AGE							
YOUNG				OLD			
METHOD OF STUDY							
SSST		STTT		SSST		STTT	
		METHOD OF TESTING					
RECOGNITION	RECALL	RECOGNITION	RECALL	RECOGNITION	RECALL	RECOGNITION	RECALL

tion between age and method of testing. The retrieval hypothesis of the memory deficit with aging predicts that younger subjects will perform significantly better than older subjects when retention is measured by recall than when retention is measured by recognition. According to the retrieval hypothesis, recognition performance taps more closely the stored items while recall performance requires a larger amount of retrieval and hence hinders older people more. The storage hypothesis, on the other hand, predicts no such interaction. If the storage hypothesis is correct, the effects of age on performance should be parallel for the recognition and recall conditions since both recognition and recall are assumed by most investigators to involve approximately equal amounts of storage.

The second hypothesis is the differential effectiveness of study trials and testing trials in aiding the performance of older subjects. The storage hypothesis seems to predict that study trials differentially aid performance in older subjects.

Hogan and Kintsch (1972) found that for younger subjects recognition performance was aided more by study trials than by test trials. This finding indicates that study trials aid in storage while test trials aid in retrieval. A third hypothesis is that younger subjects and older subjects will be aided equally by study trials when recognition is the measure of performance but that test trials will aid older subjects more than younger subjects when recall is the measure of retention. This hypothesis is the retrieval position. The storage position is that study trials will aid older people more than younger people regard-

less of whether recall or recognition is the measure of retention.

In summary, the hypotheses are:

(1) The difference between age groups will be less when recognition is the measure of retention than when recall is the measure of retention (retrieval hypothesis).

(2) Study trials enhance the performance of older people (storage) or test trials enhance the performance of older people (retrieval).

(3) When recall is the measure of retention, test trials enhance older people's performance (retrieval) or when recall is the measure of retention study trials enhance older people's performance (storage).

Table 2. Outline Of The Procedure For The Two Treatment Variables: Method Of Studying And Method Of Testing.

Cycle	Trial	Condition			
		Recognition		Recall	
		SSST	STTT	SSST	STTT
I	1	Study	Study	Study	Study
	2	Study	Recognition Test	Study	Recall Test
	3	Study	Recognition Test	Study	Recall Test
	4	Recognition Test	Recognition Test	Recall Test	Recall Test
II	1	Study	Study	Study	Study
	2	Study	Recognition Test	Study	Recall Test
	3	Study	Recognition Test	Study	Recall Test
	4	Recognition Test	Recognition Test	Recall Test	Recall Test
III	1	Study	Study	Study	Study
	2	Study	Recognition Test	Study	Recall Test
	3	Study	Recognition Test	Study	Recall Test
	4	Recognition Test	Recognition Test	Recall Test	Recall Test
IV	1	Study	Study	Study	Study
	2	Study	Recognition Test	Study	Recall Test
	3	Study	Recognition Test	Study	Recall Test
	4	Recognition Test	Recognition Test	Recall Test	Recall Test
V	1	Study	Study	Study	Study
	2	Recognition Test	Recognition Test	Recall Test	Recall Test
	3	Study	Study	Study	Study
	4	Recall Test	Recall Test	Recognition Test	Recognition Test

CHAPTER III

METHOD

Experimental Design

The experiment was designed to use a 2 x 2 x 2 factorial model with fixed effects in the levels of the experimental factors. The three factors were age, method of study and method of testing. For the age factor subjects were divided into two groups: young ($\bar{x}$=21.29, s = 2.34) and older ($\bar{x}$=52.45, s=7.75). The method of study in the experiment was either SSST in which the subject was presented with the items three times before being tested on them, or STTT in which the subject was presented with the list of words only once prior to being tested on them three successive times before the next presentation. The two types of tasks in the experiment were recall tasks and recognition tasks. Recall tasks required that the subject write down (in any order that he chose) as many of the words as he could remember. Recognition tasks required the subject to select from two alternatives the correct item which had appeared in the list. This method eliminated the "guessing" problem found with other recognition measures.

Subjects

Subjects were eighty white, apparently healthy, noninstitutionalized males ranging in age from nineteen to eighty years old. To ensure similar socioeconomic, occupational and educational backgrounds

between the two age groups, the subjects were selected from the Georgia Institute of Technology student body and alumni pool. The cutoff age for students was thirty-five years of age. Alumni between the ages of thirty-five and eighty years were used.

The alumni pool was established by writing letters to alumni residing in the Atlanta area. Included in the letters requesting their participation in memory experiments were post cards by which they indicated their willingness to serve as subjects. Interested respondents were contacted by telephone, and appointments were arranged. The return rate of post cards was between 5% and 10%.

The vocabulary and forward digit-span subtests of the Weschler Adult Intelligence Scale (WAIS) was given to all subjects. These subtests of the WAIS are known as hold subtests meaning that they change minimally with increases in age (Weschler, 1955). Hence, a comparison of mental ability could be made between younger and older subjects.

Apparatus And Test Materials

A Kodak Ektagraphic projector was used to present the stimuli, which were thirty common, monosyllabie English words with high frequency counts (AA words from Thorndike and Lorge, 1944). The list of words is presented in Appendix III. The words were projected to a height of about 1.9 centimeters onto a translucent projection screen. The words were typed in uppercase letters and were presented individually at a rate of three seconds per word. Four slide trays that contained the words in different random orders were constructed. (See Appendix III for the list of words.)

The instructions and the timing sequence of the experiments were recorded on magnetic tape with a standard cassette tape recorder. A separate tape was made for each of the four experimental groups with the initial and terminal instructions' being identical for all groups. The magnetic tapes controlled the presentation sequence of the stimuli through pulses generated by a Kodak Sound Synchronizer.

The recognition answer sheets contained thirty forced choices between two stimuli. Each word that appeared on the screen during presentation appeared once and only once in the recognition test. The incorrect alternative was equated in frequency with the correct item. That is, each was selected from AA words in Thorndike and Lorge (1944) frequency counts. There were three forms of the test, and a particular alternative appeared on no more than two of the different tests. The same form of the test did not appear on more than two tests in the same cycle. Left-right positions for the correct and incorrect alternatives were counterbalanced. (See Appendix IV for the three forms.)

Procedure

Preliminary Procedure

Individual subjects were met by the experimenter in the hallway of the experimental building and seated in the experimental chamber which was a small area partitioned from the rest of the experimental room by black felted plywood boards. The subject sat at a table facing the small (15.5 x 17.5) projection screen. The screen was about 60 cm. from the subject.

Before beginning the experiment, the experimenter (a white, twen-

ty-six year old female) obtained the subject's age, social security number, graduation class, and educational attainment. This information was obtained either verbally or in written form. (See Appendix I.)

During the preliminary period the subject was also given the vocabulary and forward digit span subtest of the WAIS. The WAIS subtests were administered and scored in raw form according to the instructions in the WAIS Manual (Weschler, 1955) with the exception that the subjects were not asked to define the first nineteen words of the vocabulary subtest. These words (e. g., bed, winter, penny, etc.) were omitted because of the superior educational level of the subjects.

Experimental Procedure

There were twenty trials in the experiment. The experimental sequences are presented in Table 2. Each trial could contain either a presentation of the list or a test on the items of the list. Four trials constituted a cycle with five cycles occurring in the experiment. On a test trial a subject received either a recognition test or a recall test.

The last cycle was identical for all four groups in terms of the types of trials presented. This cycle contained a presentation of the items or a study trial followed by a test and an adiitional presentation of the items (study trial) followed by another test (test trial). The first test in the fifth cycle was identical to the type that the subject had received during the first four cycles while the second test in the fifth cycle was the opposite kind from the one he had received previously. For example, if the subject recalled the items

during the earlier cycles, he received a recall test followed by a recognition test in the final cycle; on the other hand, if he received recognition tests during the earlier cycles, he received a recognition test followed by a recall test in the final cycle.

Initial Procedure

After completion of the WAIS subtests and the collection of demographic measures, all subjects were presented with the same instructions which are presented in Appendix II. The instructions informed the subjects of the nature of the procedure and explained the recognition and recall tasks. The subject was informed that there existed one and only one "correct" choice to each item in the recognition task: the word that appeared on the screen. A five-second pause followed the instructions during which time the subject had ample opportunity to clarify the requirements of the experiment by asking questions. If the subject asked any questions, the experimenter turned off the tape recorder and answered the inquiry before restarting the tape. After any necessary procedural clarifications had been made, the subject was presented with the list of words.

Both younger and older subjects were divided into the four groups that are presented in Table 2.

SSST-Recall Group. After the initial presentation of the list at a rate of one word every three seconds, the SSST-Recall group was presented with the list twice more before being tested on the items contained in the list. Each trial lasted 90 seconds with 20-second intervals between the trials in a cycle and between cycles. The entire cycle of three presentations of the study trials followed by one test

trial was repeated three times for a total of four cycles.

SSST-Recognition Group. The procedure of the SSST-Recognition group was similar to that of the SSST-Recall group in terms of method of studying. The subjects in this group received four cycles of three ninety second presentations of the list followed by a ninety second recognition test on the items in the list. Words were presented at a rate of one word every three seconds. Twenty second intervals occurred between each trial in a cycle and between each cycle. The fifth cycle also consisted of a presentation of the items followed by a test, an additional presentation of the items, and an additional test. The only difference between the two groups was that in the first five tests, that is, the only test in each of the four initial cycles and the first test in the fifth cycle, the subjects received a recognition test, while in the last part of the experiment the subjects were given a recall task.

STTT-Recall and STTT-Recognition Groups. The STTT-Recall and STTT-Recognition groups were similar to the first two groups in terms of the manner of testing. The recall groups received the same types of tests as the first recall group and the recognition group received the same types of tests as the first recognition group. The differences in the STTT and SSST groups were in the method of studying. After being presented with the list at the beginning of the experiment, the subjects in the STTT groups were given three tests on the items of the list. There were four cycles of a presentation of the list followed by three test trials.

In the fifth and final cycle the STTT-Recall group received identical treatment to that of the SSST-Recall groups: an STST procedure of a study session followed by a recall test, an additional study session and a recognition test. The STTT-Recognition groups received identical treatment to the SSST-Recognition group in the final cycle: a study session followed by a recognition test, another presentation of the list, and finally a recall test.

Compensation

After completing the experiment, the subjects in each group were thanked by the experimenter and compensated for participating in the study. The compensation for each older subject was $3.00, and for the younger subject, the compensation was a credit slip for extra-credit in an introductory psychology class..

CHAPTER IV

RESULTS

The first test in the fifth cycle constituted the experimental test. In the fifth cycle each group received a presentation of the items followed by the appropriate experimental recognition or recall test. Thus each group was subject to the same elapse of time between the initial presentation of the items and the administration of the crucial test. This method also made easier comparison of the performance between groups that participated in differing experimental procedures.

The data for the experimental test is presented in Table 3. The average retention score for all younger people on the test was 25.85 words whereas the average score for older people was 22.825 words retained correctly.

Younger people scored only slightly higher than older subjects on the recognition test. A larger difference, however, might have been obscured by the ceiling effect on the recognition test. Out of a possible thirty correct items all subjects in the younger STTT recognition group answered each item correctly and the younger SSST recognition group averaged 29.7 correct items while both of the older recognition groups answered an average of 28.4 items correctly. Ninety percent of the younger subjects and fifty percent of the older subjects in the recognition groups answered all items correctly on the final experimental

Table 3. Means And Variances For Experimental Test (First Test In Fifth Cycle).

AGE							
YOUNG ($\bar{X}$=25.85)				OLD ($\bar{X}$=22.825)			
METHOD OF STUDY							
SSST		STTT		SSST		STTT	
METHOD OF TESTING							
RECOGNITION	RECALL	RECOGNITION	RECALL	RECOGNITION	RECALL	RECOGNITION	RECALL
$\bar{X}$=29.7 s^2= 0.411	$\bar{X}$=20.1 s^2=22.490	$\bar{X}$=30.0 s^2=0.00	$\bar{X}$=23.6 s^2=19.641	$\bar{X}$=28.4 s^2=4.241	$\bar{X}$=18.3 s^2=14.011	$\bar{X}$=28.4 s^2=5.841	$\bar{X}$=16.2 s^2=18.160

test.

The zero variance in the younger STTT recognition group and the high percentage (70%) of all subjects in the recognition groups answering all items correctly presented a problem in the analysis of the data. Most analyses assume homogeneity of variance, and the zero variance cell in the younger STTT recognition group made this assumption untenable. Furthermore, the high percentage of subjects answering the items correctly made it impossible to tell in which way the scores would have interacted if there had been no ceiling effect. Because of these considerations, an analysis of variance was performed on only the recall data. The results of this analysis are presented in Table IV.

Both age and the age-by-study-method interaction were significant. First, younger subjects recalled significantly more words than older subjects, $F(1,36) = 11.67$, $p = .001$. There was no difference, however, in the effect of study method, $p = .25$. The age-by-study-method interaction tested whether study trials or test trials differentially aided the performance of older subjects, and this comparison was significant. While test trials aided the performance of younger subjects, study trials aided the performance of older subjects, $F(1,36) = 4.34$, $p = .05$.

An analysis was performed on the digit span and vocabulary subtests of the WAIS for the two age groups. For the digit span subtest, the difference between the two groups had a calculated z-score of 0.358 with a 72% chance of having occurred by chance. The vocabulary subtest had a z-score of about 1.89 with approximately a 6% chance of having occurred by chance. Surprisingly, this finding was in the opposite

Table 4. Analysis Of Variance On Recall Data Alone.

Source	DF	Sum of Squares	Means Squares	F-ratio	P-Values
Age (A)	1	211.6	211.6	1.6656	less than .001
Study Method (S)	1	4.6	4.6	0.2536	greater than .25
A X S	1	78.7	78.7	4.3387	less than .05
Error	36	653.0	18.1389		
Total	39	947.9			

direction from the memory test: older people scored higher than younger people on the vocabulary subtest of the WAIS.

The significant effect in vocabulary suggested that analysis of covariance with vocabulary as the covariate would be a more appropriate analysis for the recall data. An examination of the regression of recall scores on the covariate, however, indicated that the slope coefficient was not significantly different from zero.

CHAPTER V

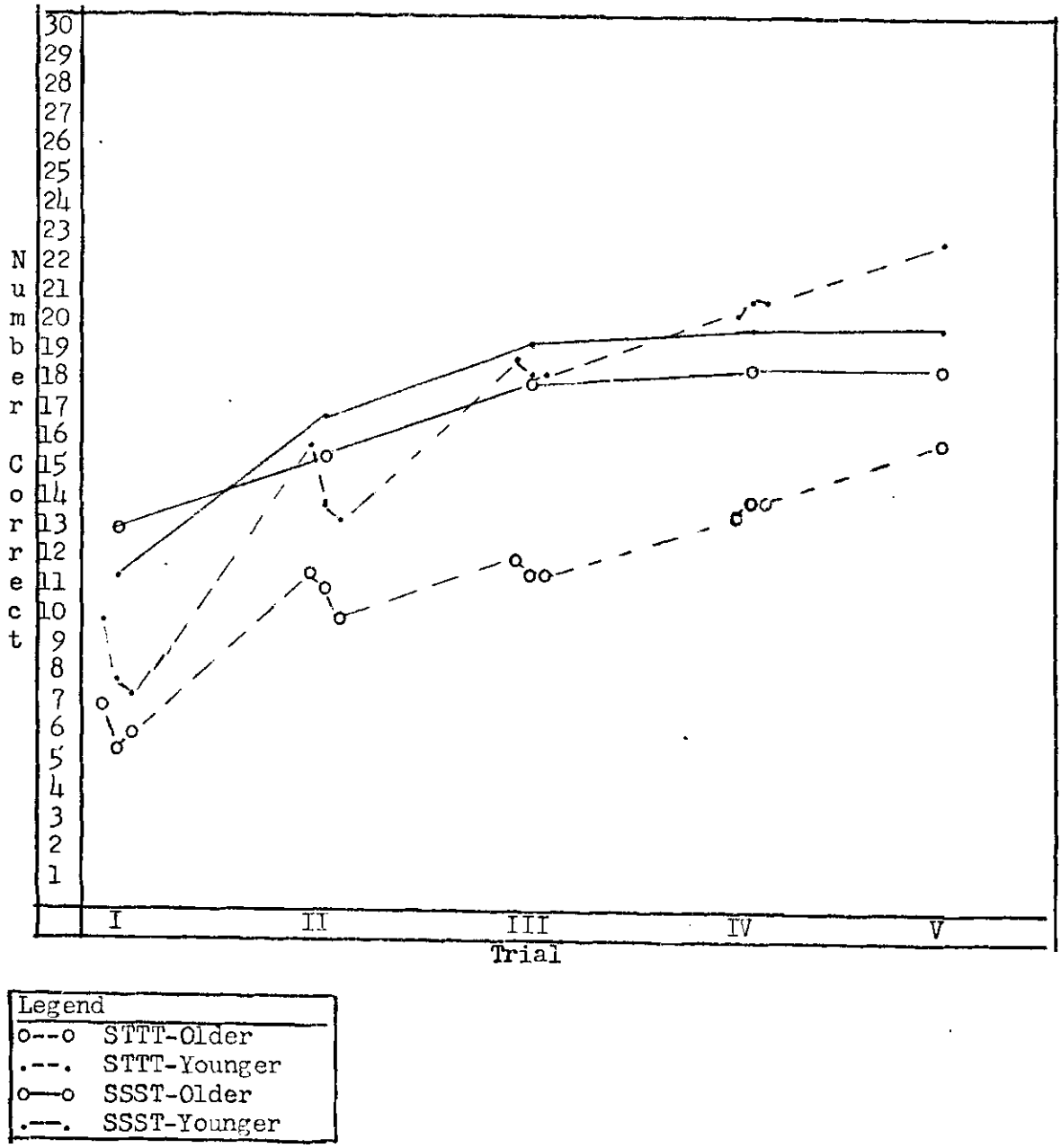
DISCUSSION

The majority of the research investigating the memory deficit with aging seems to indicate that the decreased ability of the older person to remember recently acquired verbal material is due, not to the older person's disability in learning or storing new items, but rather to inadequete retrieving or producing the items from storage. The results of this thesis seem equivocal in regard to the storage-retrieval controversy.

Unfortunately, the recognition data had a ceiling effect and one cell with zero variance causing lack of homogeneity of variance. Thus, the age-by-test-method interaction could not be compared with Schonfield's (1965) earlier finding. Schonfield failed to report on homogeneity of variance. It would seem that recall scores would have a greater variability than recognition scores, especially if the recognition data approached a ceiling.

Fortunately, the present experiment contained another method of separating storage and retrieval. Figure 1 shows the recall performance for older and younger subjects across the entire experiment. Only the first test in the fifth cycle was used in analyzing the data. The analysis indicated that the STTT method aided younger people's recall performance while it hindered older people's performance. That is, extra study trials (i.e., the SSST condition) improved the older

Figure 1. Recall Group Scores For Older And Younger Subjects.



people's performance in relation to the younger ones more than did extra test trials (STTT condition).

The problem, then, is how to reconcile the present findings with the bulk of the literature that proposes that the deficit in memory with aging is due to retrieval rather than to storage. Undoubtedly retrieval practice does occur when the SSST method is employed. One strategy during learning is to repeat each word as many times as possible while in contact with the word, and in addition, to repeat other items presented earlier. The long presentation time (three seconds per word) made this type of rehearsal possible during study trials.

It may be, as Hartley (1974) suggested, that the study trials assure a certain rehearsal for each item while rehearsal of certain chunks of items occurs during test trials. Hartley, using categorizable words with young subjects, proposed that study trials aid the subject in retrieving particular items whereas test trials aid the subject in forming chunks or categories for the items.

An interpretation of the present data in a similar manner is suggested by Laurence's (1966) finding of no difference in the tendency of younger and older subjects to recall items in a consistent pattern. Test trials, therefore, which aid subjective organization, are not needed as much by older people as study trials because older people score similarly to younger ones on measures of subjective organization. Study trials permit older subjects to add more items to their "chunks."

Another related explanation of the data is that the person participating in the STTT condition spends more time with items he already

can retrieve than does the person in the SSST condition. Although this interpretation could be construed as a storage hypothesis, there is a slight difference between retrieving items and rehearsing items already retrievable. The subject could read repeatedly responses he has already retrieved in hopes of eliciting those items he has not retrieved. Such a view holds that extra rehearsal or test trials do not aid the performance of older people as much as that of younger people because the older person is not rehearsing or retrieving an optimum number of items. In fact, study trials seem to aid the older person's performance more because study trials offer exposure to all items on each trial. Although there was no provision for statistically testing this hypothesis, the trend in the data shown in Figure 1 seems to support this hypothesis. There appears to be asymptotic performance in both the older and younger SSST groups but not in the the older and younger STTT groups.

A third explanation is that the original hypotheses concerning storage and retrieval in relation to the study methods should have been reversed. If the impaired memory of the age is due to a defect in their retrieval mechanism, according to this explanation, then test trials which make use of this retrieval mechanism would not be expected to aid older people as much as would study trials which do not use this retrieval mechanism. Thus, older people in the STTT condition might be expected to perform at a lower level than younger subjects in the STTT condition in relation to the performance of the two age groups in the SSST condition where the retrieval mechanism is not relied on as much. Although the explanation is inconsistent with the original hy-

potheses, the possibility of its validity should be considered.

Other Variables That Might Have Influenced Performance

An attempt was made to control variables other than those associated with a memory deficit per se. Botwinick (1973) as well as others have presented convincing arguments that this precaution be taken.

Cohort Differences

Since a random sample of the adult population was not feasible, it was thought best to obtain as homogeneous a group of subjects as possible. To this end alumni of the Georgia Institute of Technology were used as experimental subjects and students of the same institution were used as control subjects. Only male subjects were used. An advantage might have existed for the younger subjects, who were still in the habit of learning material, but the evidence suggested that the possible advantage was offset somewhat by the more select alumni group, who actually scored higher on the WAIS vocabulary subtest. Of course there were obvious cohort differences that could not be controlled experimentally, such as the higher probability associated with a student's having grown up with television than with the older person's having done so. Examination of interactions of age with another particular variable rather than of absolute age differences is one way of minimizing extraneous variables such as cohort differences (Hultsch, 1971). Arenburg (1977) gave evidence that longitudinal and cross-sectional studies make similar conclusions in relation to memory.

Differential Reactions To Novelty

In the STTT condition, being asked to write the items more than

once before being presented with the list again ssemed to disconcert older people more than younger people. The older subjects were more likely to suspect that an equipment failure caused the tape recorded voice to ask for a second or third writing of the list. When this procedure was used, several of the older subjects asked for clarification after the experiment started. The problem usually disappeared after the first cycle, however, and it is doubtful that the suppressed performance in the fifth cycle in the older STTT group was due to novelty effects.

Suggestions For Further Research

The greater variability in the recall data than in the recognition group data and the zero variance cell in one of the younger recognition groups made difficult comparison of the two groups. Perhaps more difficult recognition tests would eliminate this problem.

Closely related to the zero variance cell problem was the ceiling effect on the recognition performance. Similar experiments in the future might decrease the exposure to the words or increase the list of words.

The unexpected finding that differences between older and younger subjects' recall performance is greater when extra test trials are provided needs further experimental verification. Work such as Hartley (1974) has described with younger subjects could be used with older subjects to examine the paradigm when categorizable words are used. Test trials might aid older people even less when other retrieval methods such as categorizing the words are available to them. Rehearsal is only one of many procedures that facilitate retrieval.

Another suggestion for further research is to include an STST group when comparing the effectiveness of different methods of studying. Older people tended to respond at levels of performance closer to that of younger people when the SSST method was used than when the STTT method was used in the research reported here. The inclusion of an STST group might aid in determining whether the superiority of the SSST group in facilitating older people's performance was due to the novelty effects of the STTT method for older people or whether it was due to the extra study trials. If there were a greater difference between younger and older people when the STST method was used than when the SSST method was used in comparison with the STTT method, the results could be attributed to the novelty effects of the STTT method. On the other hand, a greater age difference when the SSST method was used than when the STST method was used in comparison with the STTT method might indicate the superiority was due to the addition of extra study trials.

The inclusion of only two age groups also limited this research. There is increasing evidence (cf. Smith, 1974) that some memory decrements occur in the early forties (e.g., Hultsch, 1971) and other decrements occur in the early sixties (e.g., Fozard, Nuttall & Waugh, 1972). The mean age in the present study was 52.45 years for the older subjects and 21.02 years for the younger subjects. Including three age groups might have indicated the nature of the two memory decrements experienced at the different ages (forties and sixties) in comparison with younger adults.

APPENDIX A

PRELIMINARY INFORMATION

The following two pages were used to obtain information on the subjects' age, socio-economic background, graduation date, etc. The experimenter filled in the first form, and the subject filled in the second form which appeared on the front of the answer booklet.

PSYCHOLOGY MEMORY PROJECT
School of Psychology
Georgia Institute of Technology

Date_____

S Number_____CONDITION_____

AGE_____Yr. graduated from Tech_____

S.S. Number_____Paid_____

(2, 1, or 0)

Score_____

WAIS (5 & 6)
Forward Digit Span: Vocabulary:

Highest number
circled....____

PSYCHOLOGY MEMORY PROJECT SS#_____ Date_____

School of Psychology Group_____

Georgia Institute of Technology

DO NOT OPEN YOUR ANSWER BOOKLET UNTIL TOLD TO DO SO BY THE EXPERIMENTER!

EXAMPLE

ROSE_____ APPLE____

PLEASE CHECK THE FOLLOWING INFORMATION:

Sex	Age:	Education: (Check highest level)
M____	20-29____	4th grade_____
F____	30-39____	7th grade_____
	40-49____	high school_____
	50-59____	some college_____
	60-69____	college degree_____
	70-79____	graduate work_____
	80 & over___	doctor's degree_____

APPENDIX B

TAPED INSTRUCTIONS

The following instructions were presented on a standard cassette tape recorder to all subjects in each group. The experimenter's voice was used.

Thank you for coming to Georgia Tech today and participating in the memory project. You are going to be presented with a list of words on the screen in front of you. Try to remember as many of the words as possible. After the list has been presented, the list will be presented again or you will be presented with a test on the items of the list. There are two types of tests: a recognition test and a recall test. The recall test consists of writing down as many of the words as possible. The recognition test consists of choosing between two words as to which word appeared on the screen.

Look at the example on the front of your answer booklet. If you think apple is the correct response, then you would place an X by apple. Before each particular event you will be told whether it will be a presentation of the items, a recognition test, or a recall test. If you have any questions please ask them now.

APPENDIX C

LIST OF WORDS

The following words were presented to the subjects in three random orders.

LIVE
LET
CHILD
ADD
PRICE
HORSE
GO
CHANCE
FIND
CAN
KNOW
FRONT
FEEL
CASE
CALL
HAS
KEEP
SUN
SEE
MAKE
SAY
TOWN
WEEK
WORD
SPEAK
SHIP
TREE
AIR
ONE
BILL

APPENDIX D

THREE FORMS OF THE RECOGNITION TEST

The next three pages show the three forms of the recognition test. (Note: Originally, there were four forms of the recognition test, but one had to be deleted because of an error.)

1.	ROOM___	BILL___
2.	LET___	END___
3.	GO___	HEAD___
4.	DOES___	CHANCE___
5.	WEEK___	THOUGHT___
6.	ADD___	LAUGH___
7.	PART___	CAN___
8.	HEAR___	SHIP___
9.	CASE___	MONTH___
10.	PRICE___	TRY___
11.	LIVE___	ARE___
12.	SAY___	COURT___
13.	THING___	TOWN___
14.	CUT___	SPEAK___
15.	WENT___	HAS___
16.	DROP___	KEEP___
17.	KNOW___	SET___
18.	CARE___	AIR___
19.	EACH___	FRONT___
20.	CALL___	WANT___
21.	BE___	WORD___
22.	FEEL___	HOPE___
23.	START___	TREE___
24.	STOOD___	MAKE___
25.	SEE___	FORCE___
26.	HORSE___	LIKE___
27.	FIND___	PLAN___
28.	SUN___	HELP___
29.	PASS___	ONE___
30.	CHILD___	WAR___

1.	FRONT___	FILL___
2.	DIE___	CASE___
3.	WORD___	SOW___
4.	WATCH___	GO___
5.	FIND___	FEET___
6.	ONE___	LIE___
7.	HAS___	MOVE___
8.	CALL___	DRESS___
9.	FRIEND___	LIVE___
10.	CUT___	LET___
11.	EYE___	CHILD___
12.	WRITE___	SEE___
13.	HORSE___	SEA___
14.	PART___	TREE___
15.	COME___	SAY___
16.	SHIP___	SET___
17.	BILL___	ARM___
18.	CHANCE___	SMILE___
19.	SUN___	ACT___
20.	CARE___	CAN___
21.	FACT___	SPEAK___
22.	KNOW___	FOOD___
23.	KEEP___	FEAR___
24.	FEEL___	HOUR___
25.	HEAD___	MAKE___
26.	FRIGHT___	AIR___
27.	WEEK___	LOVE___
28.	DROP___	TOWN___
29.	PASS___	ADD___
30.	HELD___	PRICE___

1.	CAN___	FALL___
2.	PLACE___	TREE___
3.	WAR___	KNOW___
4.	MAY___	CHILD___
5.	AIR___	PLAY___
6.	STEP___	SPEAK___
7.	TOWN___	WAIT___
8.	WORLD___	FRONT___
9.	KEEP___	SHOW___
10.	LINE___	SAY___
11.	CASE___	TURN___
12.	SEE___	STOP___
13.	WIFE___	WEEK___
14.	LET___	AM___
15.	GIRL___	CALL___
16.	SUN___	LAND___
17.	GIVE___	FEEL___
18.	MAKE___	WAS___
19.	CHANCE___	WORK___
20.	HAS___	GOD___
21.	STREET___	GO___
22.	FIND___	SIR___
23.	POINT___	ONE___
24.	TELL___	SHIP___
25.	HORSE___	USE___
26.	WISH___	LIVE___
27.	BILL___	STATE___
28.	WORD___	MILE___
29.	BOOK___	PRICE___
30.	SIDE___	ADD___

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